Heuristics Analysis

For this project, I created the following 3 heuristics functions:

1. Prefer move if also opponent's legal move (AB_Custom)
2. Penalize move if opponent has legal moves (AB_Custom_2)
3. Prefer any locations at least 2 spaces away from the edge (AB_Custom_3)

AB_Custom adds 8 bonus points to the result of AB_Improved if the current move is one of the opponent's move. The idea is to pick a location that is known to be most preferable by AB_Improved that is also an opponent's move so that we simultaneously move to a good position while depriving the opponent of a good position at the same time.

AB_Custom_2 is the same as AB_Improved, except it doubles the number of opponent's moves before subtracting it from the number of the player's moves. The idea is to value the enemy's move twice as much as your own so that the agent prefers a move that results in smaller number of opponent's moves compared to AB_Improved.

AB_Custom_3 is a varied combination of AB_Improved and AB_Center. Unlike AB_Center, only locations that are 2 spaces from the edges affect the score.

The performance of the heuristics functions were evaluated using the provided tournament.py configured to run 20 matches for each agent. The table below is the output from the program (darker green indicates higher value):

	AB_Improved		AB_Custom		AB_Custom_2		AB_Custom_3	
	Won	Lost	Won	Lost	Won	Lost	Won	Lost
Random	33	7	32	8	34	6	35	5
MM_Open	22	18	25	15	25	15	31	9
MM_Center	31	9	32	8	32	8	28	12
MM_Improved	28	12	28	12	23	17	27	13
AB_Open	21	19	18	22	20	20	26	14
AB_Center	25	15	24	16	26	14	20	20
AB_Improved	19	21	21	19	20	20	19	21
Total	179	101	180	100	180	100	186	94
Win Rate	63.90%		64.30%		64.30%		66.40%	

Table 1 Tournament Results

The table shows that the AB_Custom functions have a similar performance characteristics compared to the AB_Improved function in that the number of won matches tends to decrease as the agent becomes more advanced. The win rate indicates that the custom functions have a very slight increase in the win rate compared to AB_Improved.

Since we are primarily interested in comparing the performance of the custom functions against the baseline improved function, below is a graph that shows the percent variance of the custom functions against the baseline improved function. Bars that extend to the left indicate that the performance was worse compared to the baseline, while the bars that extend to the right indicate that the performance was better compared to the baseline.

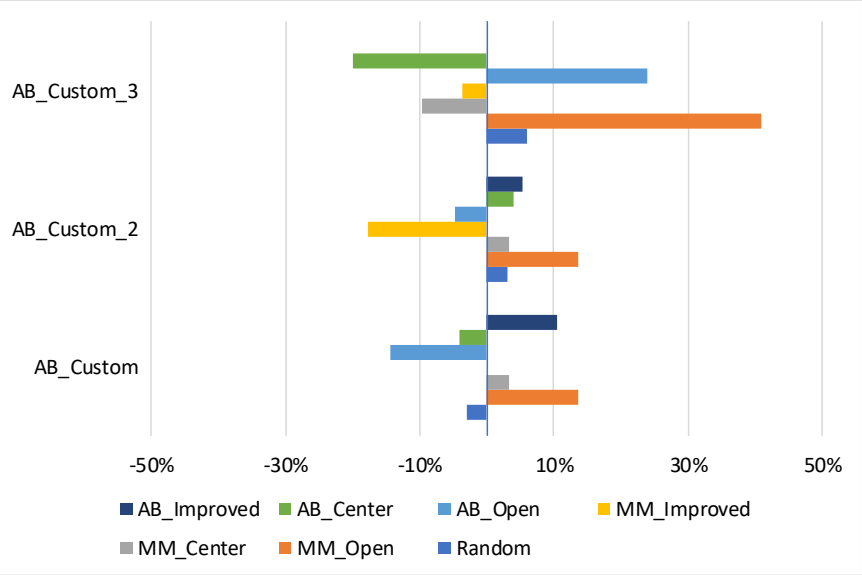

Figure 1 Percent Variance from AB_Improved

Although AB_Custom_3 returned the largest win rate, most of its wins come from matches against AB and MM Open agents, with the match against MM_Open (40% improvement) was the best of all matches tested. However, its performance against other agents are mediocre and notably its performance against AB_Center (20% decrease) was the worst of all matches tested. The performance of AB_Custom_3 was quite unstable, having the largest variance of variance when compared with other custom heuristics functions, as shown below:

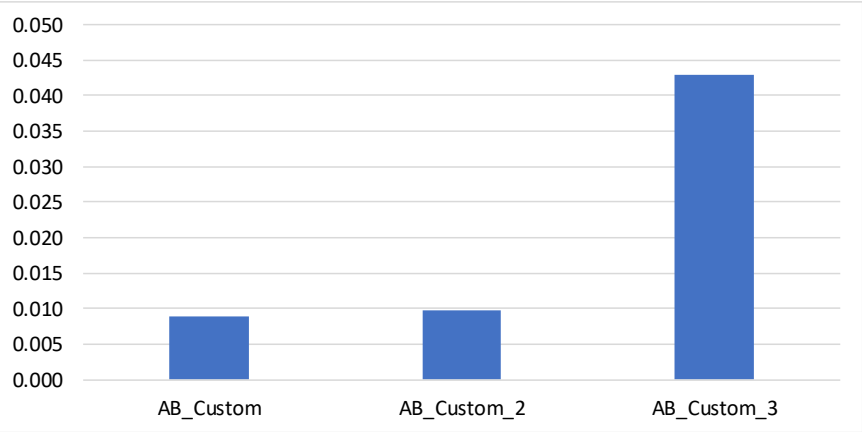

Figure 2 Variance of Variance

AB_Custom and AB_Custom_2 returned similar win rates, but AB_Custom_2 did not perform well when tested directly against MM_Improved with 18% decrease in the number of wins.

Therefore, AB_Custom seems to be the best of all 3 heuristic functions tested, with relatively stable variation in performance, no decrease in performance against MM_Improved, and 10% increase in performance when tested against AB_Improved.